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REPORT ON POLLUTION OF INTERSTATE WATERS OF THE NORTH PLATTE RIVER, TORRINGTON, WYOMING TO BRIDGEPORT, NEBRASKA

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

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REPORT ON

POLLUTION OF INTERSTATE WATERS

OF THE

NORTH PLATTE RIVER

TORRINGTON, WYOMING TO BRIDGEPORT, NEBRASKA

REGION VI
Kansas City, Missouri

REGION VIII
Denver, Colorado

U. S. Department of Health, Education & Welfare

Public Health Service

Robert A. Taft Sanitary Engineering Center

Cincinnati, Ohio

November-December 1960.

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REPORT ON
POLLUTION OF INTERSTATE WATERS
OF THE
NORTH PLATTE RIVER
TORRINGTON, WYOMING TO BRIDGEPORT, NEBRASKA

In December 1949, the Bureau of Reclamation and the U.S. Public Health Service adopted a Memorandum of Understanding Regarding Joint Program for Stream Pollution Investigations of the North Platte River Basin. Pursuant to this the U.S. Public Health Service and the States of Colorado, Nebraska and Wyoming conducted a stream survey of the North Platte River Basin from December 1949 to November 1950.

The purposes of this investigation were to determine the extent and types of pollution, to review existing laws, to evaluate the sanitary quality of irrigation waters, to make recommendations regarding minimum stream flows, to evaluate sanitary quality of water for municipal requirements and other public uses, to estimate possible benefits of reservoir releases in improving water quality, and to make recommendations for pollution abatement.

In order to determine any changes in pollution of the North Platte River in the vicinity of the Wyoming-Nebraska state line, the U. S. Public Health Service conducted stream surveys in November and December 1960.

The surveys were conducted in November and December in order to determine the conditions that existed during the sugar beet refining season. The stream reach involved receives greater waste loads during the period of sugar beet plant operation than during other periods of the year.

The November study was devoted to examination of the effects of pollution on the biology of the stream, with especial reference to the impact on its fishery resources. This survey extended from above the Holly Sugar Company plant at Torrington, Wyoming downstream across the Wyoming-Nebraska state line to Morrill, Nebraska, about 18 miles below Torrington.

The December study involved examination of the effects of wastes on bacteriological, chemical, and physical quality of the river. The reach of river involved extended from above Torrington downstream to Bridgeport, about 67 miles below Torrington. In addition, a few samples for dissolved oxygen analysis were collected below Lake McConaughy, about 147 miles below Torrington.

NOVEMBER 1960 SURVEY

REACH OF RIVER

This report concerns influences of industrial wastes discharged in fall and winter to the North Platte River by a sugar beet factory at Torrington, Wyoming, about 9 river miles above the Wyoming-Nebraska state line. On the above date, this highly turbid, foaming discharge, which enters through a sewer on the right bank below the bridge on U. S. Highway 85 quickly spread to discolor about one-half of the stream. This amount of coverage persisted for about 7 miles to a diversion dam, where complete mixing was accomplished by flow through a narrow control channel. Below there, the river was muddied over its entire width; and, at the Nebraska line, character of all water and bottom was affected by the Torrington beet factory discharge.

METHODS OF STUDY

Samples were collected and visual observations of stream conditions were made during November 16 and 17, 1960.

Other than irrigation and conveyance of liquid wastes, water use potential in this section is largely vested in fishing and duck shooting. It therefore appeared that interstate damages to water resources could be reasonably assessed by study of the benthos or bottom life, since this population has a large control over fish life, and fishing offers considerable recreational promise. Accordingly, areas that were expected to show (1) changes of bottom and benthos caused by beet wastes at various stages of its mixing into the river and (2) how well bottom life fared above entrance of these wastes were sampled. These stations were:

Station 1 - North Platte River above entrance of beet waste at Torrington, Wyoming.

Station 2 - About 1 mile below entrance of beet wastes. 2a under clear water extending from left bank; 2b under water discolored by beet wastes right of center.

3. South of Henry, Nebraska. 10 miles below entry of beet waste.

4. At Morrill, Nebraska. 18 miles below Torrington.

At Stations 1, 2a, and 2b, a total of 20 square feet of bottom was turned up in representative areas and organisms dwelling therein caught in a net; at Station 3, 20 Peterson dredge samples were equally spaced across the stream; and at Station 4, 5 dredge samples were considered sufficiently representative. Some specimens were picked off driftwood at Station 1.

BOTTOM TYPES

Sand is a predominant bottom material in this section of the river, but rubble, shingle, and gravel are common enough to offer a variety of habitats. At Station 1, gravel, shingle, and large rocks were common, and considerable accumulations of driftwood were caught on the low-head dam below the bridge on U. S. Highway 85. Large sand bars also occurred. At Station 2, the stream bed was covered with a mixture of gravel and stones embedded in sand. Beet particles, cassettes, roots, and tops were common on the right, where stones and gravel were overlaid with silt. Sand covered most of the bottom at Station 3; gravel and shingle were rare, but pockets of silt and beet particles were abundant. Sand was also the major bottom component at Station 4; beet particles were common, but they were generally dispersed and not collected in pockets.

VEGETATION

No plant growth was observed under water carrying beet wastes (Stations 2b, 3, and 4), but luxuriant crops of algae occurred at Stations 1 and 2a. Waving fronds of Cladophora and Compsopogon (Table 1) were attached to rocks and driftwood at Station 1, and Cladophora formed a patchy green carpet at Station 2a. Many diatoms were attached to the filamentous algae at these two localities, and they also developed brown gelatinous plates that were scattered among other algae.

BENTHIC ANIMALS

Types and relative abundance of organisms recovered from samples are shown in Table 2. Disappearance of valuable types of organisms (stone flies, may flies, caddis flies, etc.) from areas

TABLE 1

NORTH PLATTE RIVER
BENTHIC ALGAE
November 16 and 17, 1960

Station 1:

Green Algae

Cladophora sp. (dominant growth)

Cosmarium sp. (rare in *Cladophora* fronds)

Diatoms (attached to *Cladophora* and *Compsopogon* and adhering to rocks as gelatinous patches)

Nitzschia sigmoidea

Nitzschia spp.

Diatoma vulgare (dominant diatom)

Synedra sp.

Mastogloia spp.

Navicula spp.

Cymbella spp.

Gomphonema spp.

Red Algae

Compsopogon sp.
Prostrate filaments with many attached diatoms

Station 2a:

Cladophora was the dominant growth and it was thickly invested with the above diatoms. Brown patches of diatoms occurred among green filaments.

Compsopogon was not observed.

Stations 2b, 3, and 4:

No attached algae noted.

TABLE 2

NORTH PLATTE RIVER
BENTHIC ANIMALS
November 16 and 17, 1960

	Sta 1	Sta 2a	Sta 2	Sta 3	Sta 4
Platyhelminthes					
Turbellaria					
Tricladida					
Planariidae					
Dugesia sp. 3/	++++				
Annelida					
Oligochaeta					
Tubificidae 3/				+	
Arthropoda					
Crustacea					
Amphipoda					
Talitridae					
Hyalella azteca 1.2/	+				
Insecta					
Ephemeroptera					
Heptageniidae					
Heptagenia sp. 1.2/	+				
Baetidae					
Baetis sp. 1.2/	+	+			
Plecoptera					
Perlidae					
Perlesta placida 1.2/	+				
Trichoptera					
Hydropsychidae					
Hydropsyche sp. 1.2/	++++	++			
Diptera					
Simuliidae					
Eusimulium sp. 2/	++++				
Chironomidae					
Orthocladiinae					
Spaniotoma nivoriunda 3/			+		
Spaniotoma (Orthocladius) sp. 3/	+++	+++			
Spaniotoma sp. 3/				+	
Metriocnemus sp. 3/		+			
Cardiocladius sp. 3/			+		
Chironominae					
Chironomus (Polypedilum) sp. 3/					+
Chironomus (Sticto.) flavicingula 3/					+
Anthomyiidae					
Limnophora aequifrons	+				

\+ = Present +++ = Numerous
++ = Sparse ++++ = Abundant

1/ Desirable types in fish food chains
2/ Clean water forms.
3/ Forms with pollutional tolerance.

affected by the beet wastes is clearly shown. Only very tolerant forms were able to contend with the beet wastes, and these types were very rare in polluted areas. Each species indicated for Stations 2b, 3, and 4 was represented by only one specimen. Available dilution and precipitation that took place were insufficient to ameliorate deleterious effects of beet wastes over the sampled reach. In Wyoming, about one-half the stream was affected for 7 miles and all the bottom for about 2 miles.

FISHES

No special attempt was made to collect this group, but suckers (Catostomus commersonii sucklii Girard) were taken in the bottom net at Station 1, and the western long-nosed dace (Rhinichthys cataractae ocella Garman) was obtained in clear water (Station 2a) 1 mile below. No fishes were noted in turbid water.

Fish collections made with an electric shocker by the Wyoming Game and Fish Department in October 1957 indicated definite avoidance of the turbid areas by most species of fish.

DISCUSSION

Discharge records at the time of these studies yield average flows of 255 cfs at Torrington and 285 cfs at the Wyoming-Nebraska state line.

Flow Records in North Platte River

Date 1960	Torrington (above beet waste)	Wyoming-Nebraska Line
November 13	254 cfs	284 cfs
14	254	284
15	266	296
16	260	290
17	254	284
18	248	278
19	248	278

Bottom materials play a large role in determination of types and abundance of bottom fauna, and sand is favored by relatively few. However, some areas capable of supporting a varied fauna were/or had been present at each station, and sand, silt, and

organic materials settled from the beet wastes caused unfavorable change in the physical environment. Some animals that disappeared below Stations 1 and 2a are known to inhabit sandy substrates of unpolluted streams.

Many types of algae grow poorly on sandy bottoms, but diatoms, which were luxuriant in areas escaping the beet discharge, were not adverse to sand, and sedimentation and high turbidity are assumed responsible for their absence in polluted regions. Lack of other algae in contaminated areas is referable to the same effects.

CONCLUSIONS

Discharge of sugar beet wastes into the North Platte River at Torrington, Wyoming, damages Nebraska interests in this water resource as follows:

1. Growth of aquatic vegetation (algae) that is basic in food chains of desirable aquatic organisms and of great importance in aeration of water and reduction of organic materials, is inhibited by the high turbidity, siltation, and deposit of beet trash that these wastes induce over the entire stream width.

2. Desirable bottom organisms are also eliminated by essentially the same waste influences.

3. Suspended and dissolved waste materials are avoided by fishes and actions 1 and 2 above destroy their food resources.

4. Effects of the Torrington wastes largely negate recreational use of the North Platte River as it enters Nebraska, and the damage may be assessed as complete loss of the fishery resource that could otherwise be developed.

DECEMBER 1960 SURVEY

REACH OF RIVER

The reach of river involved is the North Platte River near the Wyoming-Nebraska state line, from above Torrington, Wyoming, to below Bridgeport, Nebraska.

SOURCES OF WASTES

During the period of this survey both domestic sewage and industrial wastes were discharged to the stream. These wastes are listed in Tables 3 and 4. Table 3 is a listing of individual wastes and Table 4 presents a summary of the wastes discharged from the major sources. The locations of these sources are shown in Figure 1.

Since 1950 there have been changes in waste treatment. Sewage from Torrington, Wyoming is treated in waste stabilization ponds. There was no evidence of discharge from the ponds during the survey.

According to a waste control evaluation report on the Holly Sugar Company at Torrington, in October 1957, the following improvements have been made:

1. Three settling ponds have been provided for the lime slurry pond effluent and the Steffen's wastes.

2. A travelling screen in the main sewer, which removes particles from the flume and wash water has been in operation since 1955.

3. A pump was installed in 1955 to return the pulp silo drainage to the pulp silo screen.

4. Also, barometric condenser water is virtually all re-used in other operations at this plant.

   At Bayard, Nebraska, the Great Western Sugar Refinery uses broad field disposal of its wastes.

TABLE 3

NORTH PLATTE RIVER STREAM SURVEY
WYOMING-NEBRASKA
December 1960
SOURCES OF WASTE*

Source	Discharge at River Mile	Sewered P.E.	BOD-PE	SS-PE**
Torrington, Wyo	209			
Holly Sugar Co.	206		370,000	1,900,000
Henry, Nebraska	199			
Platte Valley Poultry			500	
Horse Creek, Lyman, Neb.	194	350	350	
Morrill, Nebr.	191	600	840	
Mitchell, Nebr.	184	1,800	2,600	
Great Western Sugar Ref.	184		156,000	1,409,000
Scottsbluff, Nebr.	173.8	9,000	12,520	
Co-op Cannery	173.8		4,000	1,000
Co-op Oil Refinery	173.8		1,200	2,400
Flicker Packing	173.8		550	
Great Western Sugar Ref.	173.8		623,000	2,200,000
H.&B. Packing Co.	173.8		720	
Hersch Packing Co.	173.8		1,160	
Idlewild Dairy	173.8		1,600	
Scottsbluff Rendering	173.8		2,200	
Gering, Nebr.	173.	1,400	1,400	
Great Western Sugar Ref.	173.		96,000	1,300,000
Miller Packing Co.	173.		100	
Swift & Co. Pack.	173.		33,000	11,000

TABLE 3 - Continued

Source	Discharge at River Mile	Sewered P.E.	BOD-PE	SS-PE**
Melbeta, Nebr.	166	80	80	
Munitave, Nebr.	166	800	800	
Bayard Canal	150			
Bayard, Nebr.		1,700	1,700	
Great Western Sugar Ref.			48,000	1,400,000
Bridgeport, Nebr.	142	1,000	2,390	
Broadwater, Nebr.	127	150	150	

* Based on 1957 Inventory, Municipal & Industrial Waste Facilities.

** 1950 Estimates Water Pollution Investigation - North Platte River Basin - USPHS.

TABLE 4

NORTH PLATTE RIVER STREAM SURVEY
WYOMING-NEBRASKA
December 1960
SUMMARY OF MAJOR SOURCES OF WASTES

Source	Discharge at River Mile	Sewered P.E.	BOD-PE	SS-PE*
Torrington, Wyoming	206	0*	370,000	1,900,000
Mitchell, Nebraska	184	1,800	157,600	1,400,000
Scottsbluff & Gering, Nebr.	173	13,400	777,450	3,514,000
Bayard, Nebraska	150	1,700	49,700	1,400,000

*No evident discharge from sewage stabilization ponds during survey.

** 1950 Estimates Water Pollution Investigation - North Platte River Basin - USPHS.

SAMPLING STATIONS

The period of sampling was December 7 to December 13, 1960. Eight sampling stations were located on the main stream, above and below major sources of wastes, and above and below the Wyoming-Nebraska state line. One sampling station was on the waste discharged from Holly Sugar Company at the mouth of the sewer. Table 5 gives a description of these stations. Figure 1 shows the locations relative to the sources of waste.

SAMPLING

One grab sample a day was collected from each station for the seven days, except at NP62.0. The time of sampling at each station varied from early in the morning to early afternoon. Samples were collected in accordance with Standard Methods for the Examination of Water and Wastewater, Eleventh Edition, 1960.

LABORATORY

Laboratory facilities were located at the branch laboratory of the Nebraska Department of Public Health, Scottsbluff, Nebraska. Personnel of the Department of Public Health cooperated by making examinations for coliform bacteria.

All analyses were made in accordance with Standard Methods, Eleventh Edition. Laboratory determinations were made for:

1. pH.
2. Alkalinity; phenolphthalein and total.
3. Dissolved oxygen.
4. Five-day 20°C BOD.
5. Total suspended solids.
6. Fixed suspended solids (at HS-1 only).
7. Coliform MPN.

FLOW MEASUREMENTS

Average daily flows were furnished by the U.S. Geological Survey at Casper, Wyoming. Gaging stations were at NP199.0, NP173.8, NP165.6 and NP141.8.

TABLE 5
NORTH PLATTE RIVER STREAM SURVEY
WYOMING-NEBRASKA
December 1960
SAMPLING STATIONS

Sampling Stations:	Location
NP-208.8 - Bridge	U. S. Hwy. 85, southern edge of Torrington, Wyoming, above all sources of wastes.
NP-199.0 - Bridge	State Hwy. 86, about 1 mile south of Henry, Nebraska
NP-191.6 - Bridge	State Spur. 226, about 1-1/2 miles south of Morrill, Nebraska.
NP-173.8 - Bridge	State Hwy. 29, between Scottsbluff and Terrytown-Gering, Nebraska. Station about one-quarter width of river from southern bank to avoid wastes from Scottsbluff discharged above bridge. Sample from western lane of bridge.
NP-154.6 - Bridge	U.S. Hwy. 26, about 1-1/2 miles south of Bayard, Nebraska. Station near northern edge of the southern main channel.
NP-141.8 - Bridge	U.S. Hwy. 385, about 1/4 mile north of Bridgeport, Nebraska.
NP- 62.0 - Bridge	State Hwy. 61, about 8 miles north of Ogalla, Nebraska.
HS-1	Waste discharge from Holly Sugar Co., at Torrington, Wyoming, at mouth of sewer. Sewer discharges just downstream from bridge, U.S. Hwy. 85, on southern bank.

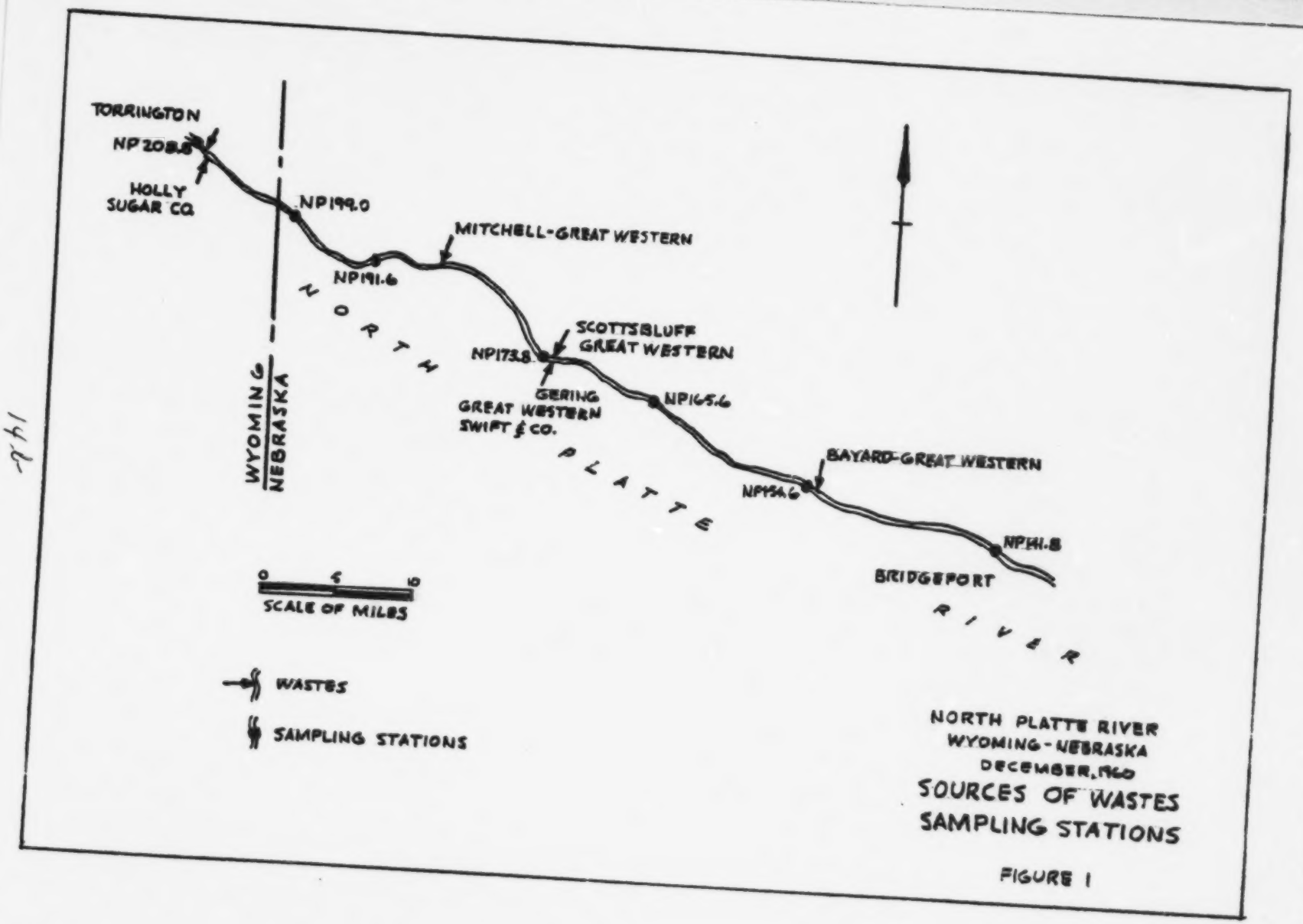

TORRINGTON
NP 208.8
HOLLY SUGAR CO.
NP 199.0
MITCHELL-GREAT WESTERN
NP 191.6
SCOTTSBLUFF GREAT WESTERN
NP 173.8
GERING GREAT WESTERN SWIFT & CO.
NP 165.6
BAYARD-GREAT WESTERN
NP 154.6
NP 141.8
BRIDGEPORT
WYOMING
NEBRASKA
NORTH PLATTE RIVER
0 5 10
SCALE OF MILES
WASTES
SAMPLING STATIONS
NORTH PLATTE RIVER
WYOMING - NEBRASKA
DECEMBER, 1960
SOURCES OF WASTES
SAMPLING STATIONS

FIGURE 1

RESULTS OF SURVEY

Table 6 presents a summary of the data as arithmetic averages. Individual results appear in the Appendix.

These average values are shown graphically in Figures 2, 3, 4 and 5. The graphs represent coliform MPN's and BOD, DO, and suspended solids in mg/l.

DISCUSSION

The results of the survey, presented in Table 6, and Figures 2, 3, 4 and 5 reveal a clean stream above Torrington, Wyoming but gross pollution below Torrington and downstream to Bridgeport, Nebraska.

COLIFORM BACTERIA

Coliform bacteria averaged 214 per 100 ml above Torrington, but were in excess of 132,000 MPN per 100 ml at all stations below Torrington.

The coliform density was 329,000 per 100 ml at NP199, below the Holly Sugar Company. This high value is attributed to wastes from the sugar beet refinery and to any sewage from plant employees that may reach the stream. The sugar beet refining wastes, which include flume water and wash water, contain coliform bacteria native to soil and from animal feces. Also, the wastes supply nutrients which allow multiplication of these bacteria in the waste streams within the plant and in the river.

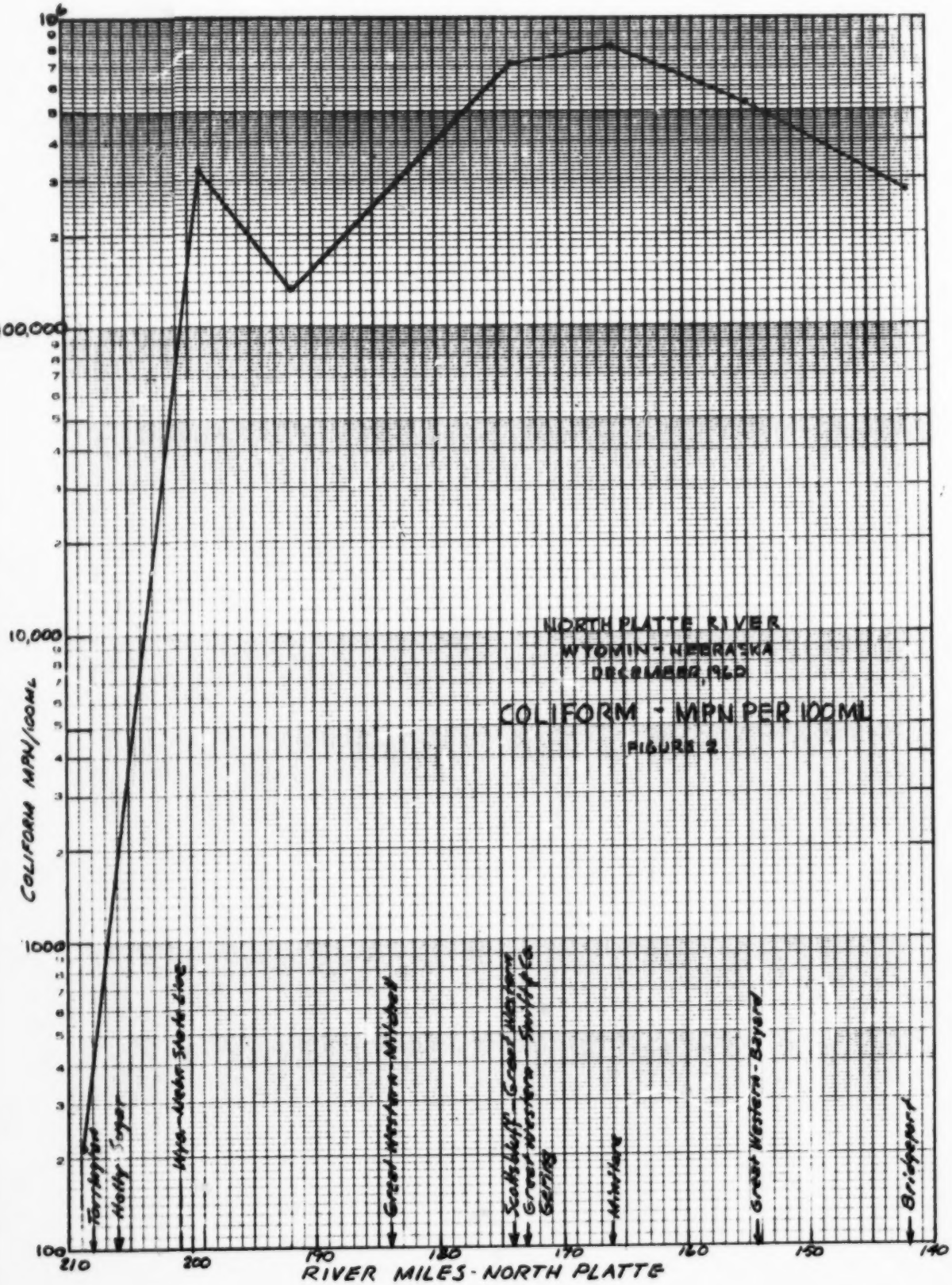
The coliform density decreased to 132,000 per 100 ml at NP191.6. Below Mitchell, Nebraska, at NP173.8, the coliform MPN increased to 704,000 per 100 ml. This reflects the effects of the sugar beet wastes from the Great Western Refinery at Mitchell.

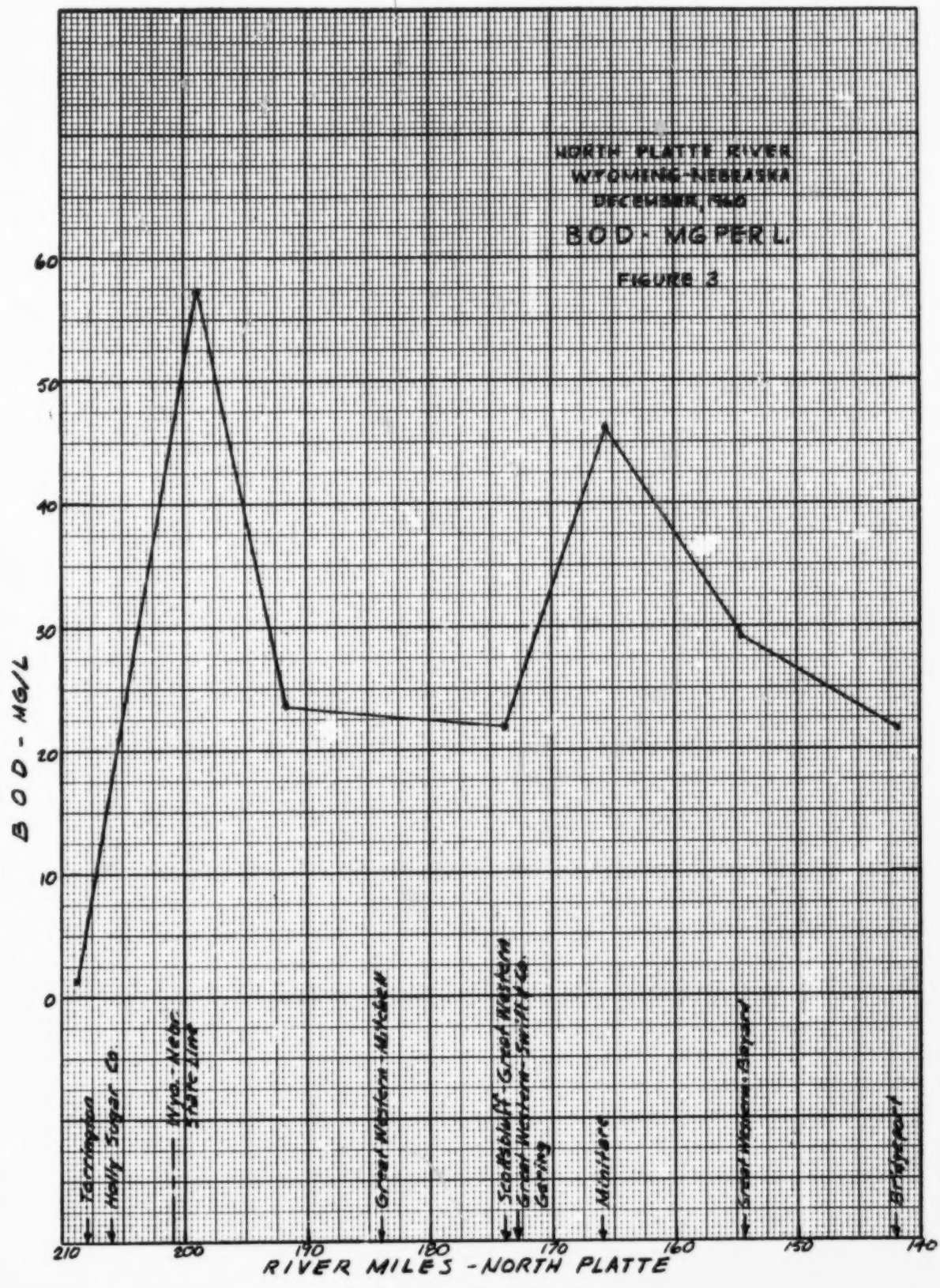
At NP165.6 the MPN increased to 815,000 per 100 ml. This was due to sewage and industrial wastes from the Scottsbluff-Gering area. The effects of dilution and die-off are reflected at NP154.6 and NP141.8, with coliform MPN's of 537,000 per 100 ml and 279,000 per 100 ml, respectively.

TABLE 6

NORTH PLATTE RIVER STREAM SURVEY
WYOMING-NEBRASKA
December 1960
SUMMARY OF DATA

Station	Flow cfs	Temp. °C	pH	Alkalinity P	Alkalinity Total	D.O. mg/l	D.O. Sat %	BOD mg/l	BOD lbs/da	Tot Susp. Solids mg/l	Tot Susp. Solids lbs/da	Coliform MPN/ 100ml
NP208.8	278	0.5	8.1	0.3	217	11.03	88	1.41	2,116	7.83	11,750	214
NP199	278	0.4	8.1	0	247	8.57	69	57.3	86,000	48.9	73,500	329,000
NP191.6	328	0.3	8.1	0	242	9.70	77	23.6	41,740	133.0	235,000	132,000
NP173.8	447	0.3	8.1	0	290	8.34	66	22.2	53,620	128.0	310,000	704,000
NP165.6	686	0.4	8.2	1.0	379	5.44	43	46.4	171,800	284.0	1,052,800	815,000
NP154.[illegible]	805	0.3	8.2	0.5	371	5.55	44	29.3	127,300	252.0	1,096,000	537,000
NP141.8	943	0	8.1	0	377	8.04	63	21.7	110,620	272.0	1,392,170	279,000
NP62		2.5				13.33	112					
HS1	13.4	36				Fixed Susp. Solids mg/l 2,702	lbs/day 196,000			3,963	229,000	


NORTH PLATTE RIVER
WYOMIN - NEBRASKA
DECEMBER, 1960
COLIFORM - MPN PER 100 ML
FIGURE 2
COLIFORM MPN/100 ML
100,000
10,000
1000
100
210
200
190
180
170
160
150
140
RIVER MILES - NORTH PLATTE
Torrington
Hollyr Sugar
Hyo-Wyo State Line
Great Western-Mitchell
Scottsbluff Great Western
Great Western Scottsbluff
Gering
Minatare
Great Western-Bayard
Bridgeport


NORTH PLATTE RIVER
WYOMING-NEBRASKA
DECEMBER, 1960
BOD - MG PER L.
FIGURE 3
B O D - MG/L
60
50
40
30
20
10
0
Torrington
Holly Sugar Co.
Wyo.-Nebr. State Line
Gering Western-Nitrokem
Scottsbluff-Gering Western
Gering Western-Swift Co.
Gering
Minatare
Gering Western-Bayard
Bridgeport
210
200
190
180
170
160
150
140
RIVER MILES - NORTH PLATTE

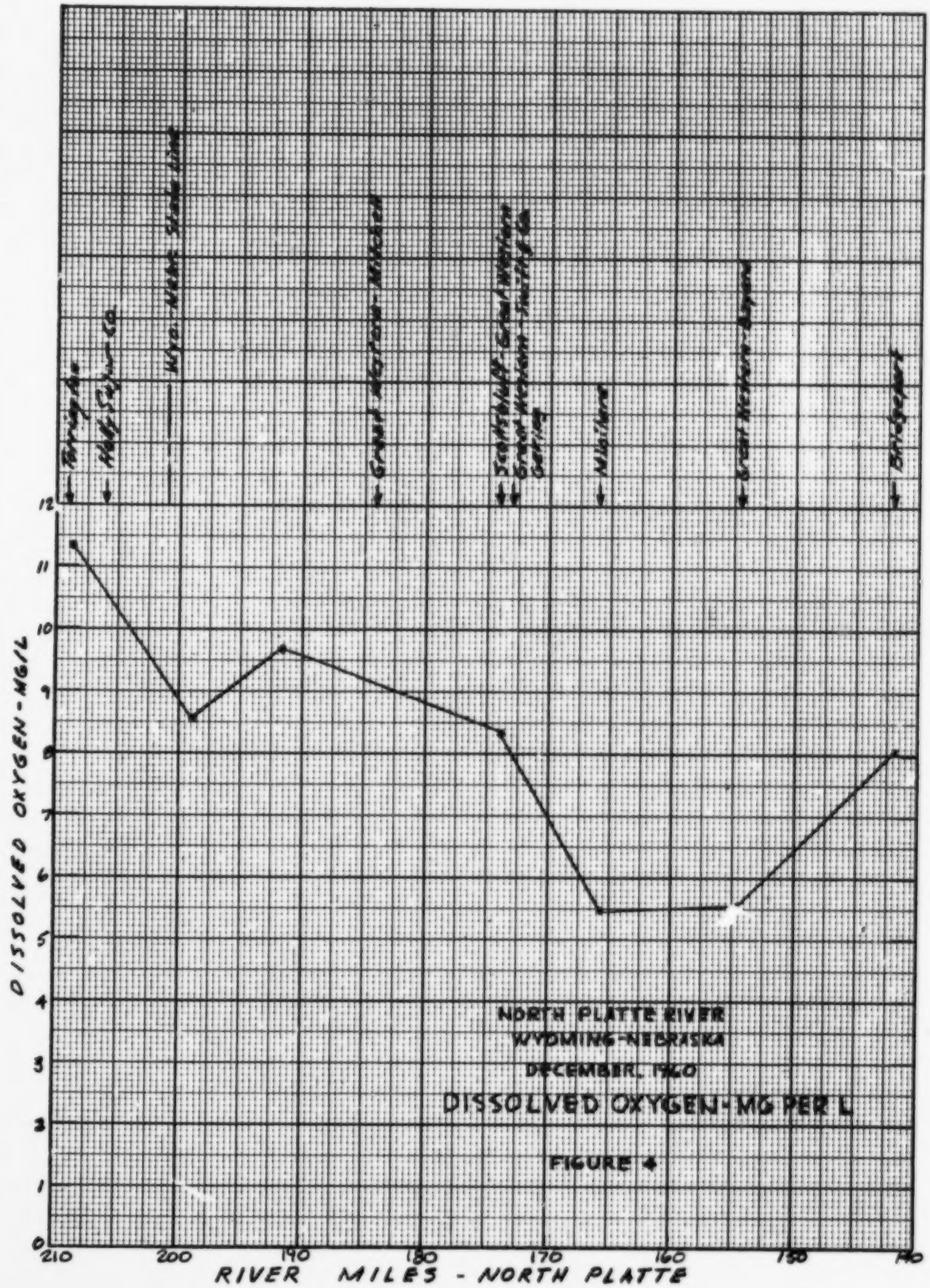
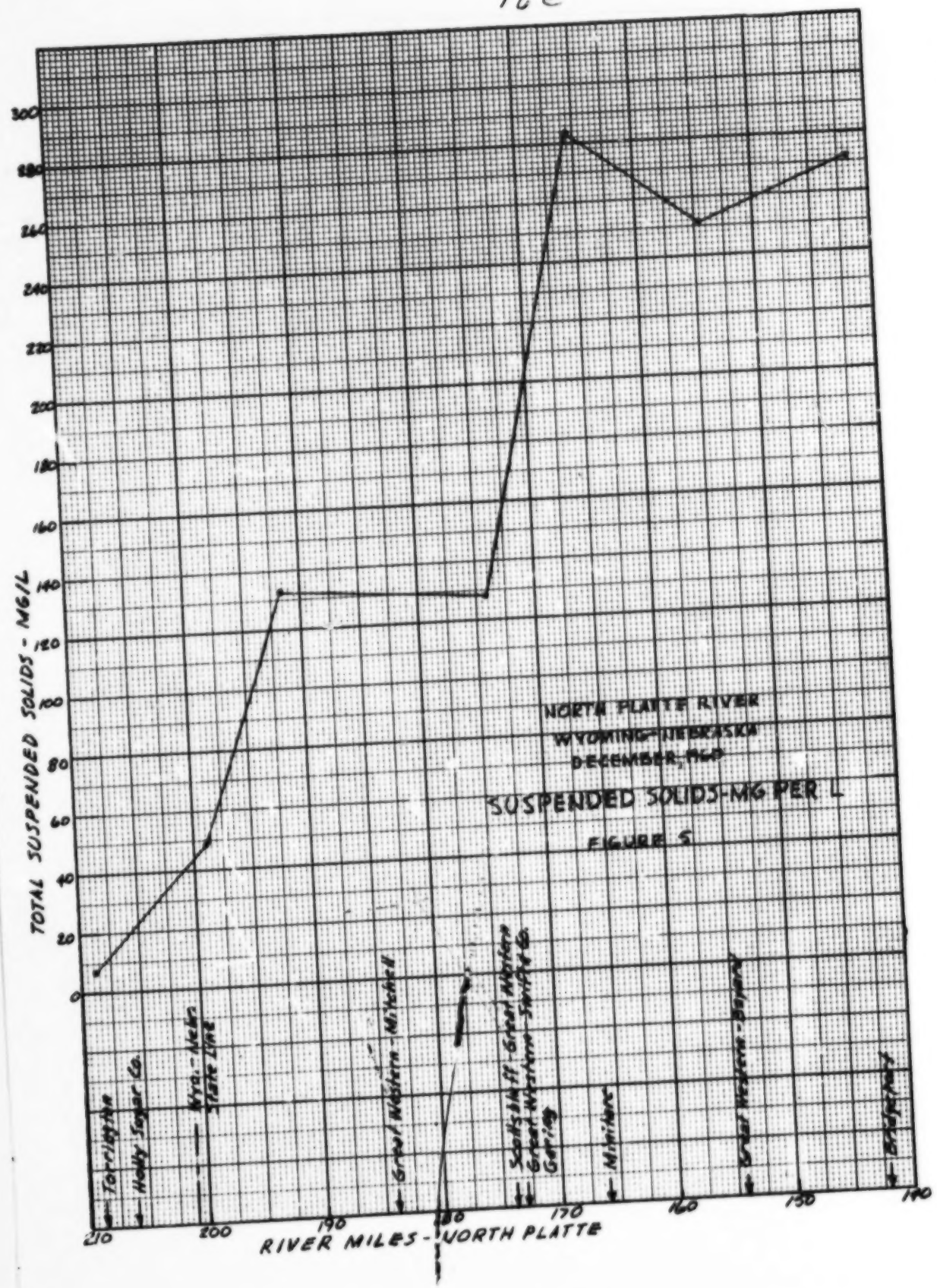

DISSOLVED OXYGEN - MG/L
0
1
2
3
4
5
6
7
8
9
10
11
12
210
200
190
180
170
160
150
140
RIVER MILES - NORTH PLATTE
NORTH PLATTE RIVER
WYOMING-NEBRASKA
DECEMBER, 1960
DISSOLVED OXYGEN - MG PER L

FIGURE 4


TOTAL SUSPENDED SOLIDS - MG/L
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
NORTH PLATTE RIVER
WYOMING-NEBRASKA
DECEMBER, 1960
SUSPENDED SOLIDS-MG PER L
FIGURE 5
Torrington
Holly Sugar Co.
Wyo.-Nebr. State Line
Gering-Mitchell
Scotts Bluff-Gering Workers
Gering
Minatare
Scotts Bluff-Bayard
Bridgeport
210
200
190
180
170
160
150
140
RIVER MILES - NORTH PLATTE

BOD - D.O.

The average BOD above Torrington was 1.41 mg/l and DO was 11.03 mg/l. Average BOD results at all stations below Holly Sugar Company were in excess of 21.7 mg/l. The data show high BOD averages of 57.3 mg/l at NP199.0, below Holly Sugar Company, and 46.4 mg/l at NP165.6, below the Scottsbluff-Gering area.

Using the rate of BOD reduction indicated by the stream data, the quantities of BOD from the various areas were calculated. These are presented in Table 7.

TABLE 7

QUANTITY OF BOD COMPUTED
FROM STREAM DATA
December 1960

Vicinity	BOD	
	#per day	PE
Torrington, Wyoming & Holly Sugar Company	60,000	352,000
Mitchell, Nebraska	38,000	223,000
Scottsbluff-Gering	168,000	988,000
Bayard, Nebraska	35,000	206,000

In comparison with the value of 370,000 given in Table 4, the PE of 352,000 from Torrington, Wyoming, agrees quite well. However, the values computed from stream data exhibit higher PE's for the other sources than the 1957 inventory. (Table 4) Especially interesting is the much higher PE of 206,000 compared to 49,700 in Table 4, from the Bayard, Nebraska, Great Western Sugar Refinery which has provisions for broad field disposal of the beet sugar wastes.

Because of weather conditions, existing prior to and during the survey, the BOD values from the sugar beet plants were probably above normal.

Temperatures below freezing occurred, and there was considerable snowfall. It is reported that both freezing and wet weather

increase the pounds of BOD per ton of beets by as much as fifty percent. Organic matter and sugar dissolved from spoiled or frozen beets contribute to the additional load of pollution.*

The D.O. dropped from 11.03 mg/l (88 percent saturation) at NP208.8 to 8.57 mg/l (69 percent saturation) at NP199.0. It recovered slightly at NP191.6 to 9.70 mg/l (77 percent saturation). Below Mitchell the effects of the sugar beet wastes dropped the D.O. to 8.34 mg/l (66 percent saturation). Farther downstream, below the Scottsbluff-Gering wastes, at NP165.6 and NP154.6 the D.O. dropped to 5.44 mg/l (43 percent saturation) and 5.55 mg/l (44 percent saturation) respectively. Individual D.O. results at NP165.6 were as low as 4.71 mg/l and 5.00 mg/l. One result at NP154.6 was 4.21 mg/l.

Natural purification, plus dilution, resulted in D.O.'s of 8.04 mg/l at NP141.8 and 13.33 mg/l at NP62 in spite of the BOD from the Great Western Plant at Bayard.

It has been calculated that, in order to assure maintenance of a minimum of 5.0 mg/l D.O. content in this reach of river, waste from each sugar beet refinery must not contain more than 8.0 to 8.5 pounds of BOD per ton of beets processed. A winter low flow of about 330 cfs at the state line, expected to prevail once in five years, was used in computing the allowable BOD's.

During the December 1960 survey the flow at the state line was 278 cfs, which is about a ten-year low flow. Based on plant capacities for beets processed by the various refineries, the following estimate of pounds of BOD per ton of beets processed per day was made for this survey:

Holly Sugar Company	19.4
Great Western at Mitchell, Neb.	20.0
Combined Sugar Beet Wastes in Vicinity of Scottsbluff	33.4
Great Western at Bayard, Neb.	19.0

During the survey the D.O. averages did not drop below the 5.0 mg/l. However, earlier in the sugar beet refining season, when the temperatures probably were 10 or 11°C. higher, the solubility of oxygen would have been lower than those at the

*Broad Field Disposal of Sugar Beets, Porges, Ralph, Hopkins, C.J., Sewage and Industrial Wastes, Vol. 27, No. 10, p. 1160, (October 1955)

temperatures which existed during this survey and rates of deoxygenation would have been higher. Earlier in the season D.O. conditions probably would have been worse than existed during the December survey.

SUSPENDED SOLIDS

Suspended solids loads computed from stream data are prosented in Table 8.

TABLE 8

QUANTITY OF SUSPENDED SOLIDS COMPUTED FROM STREAM DATA

December 1960

Vicinity	Total Suspended Solids # per day	PE
Torrington, Wyoming & Holly Sugar Company	214,300	790,000
Mitchell, Nebraska	75,000	277,000
Scottsbluff-Gering	742,800	2,750,000
Bayard, Nebraska	292,200	1,080,000

By direct difference of suspended solids in pounds per day between NP208.8 and NP191.6, the data show that 214,200 pounds per day can be attributed to Holly Sugar Company. Analysis of the Holly Sugar Company waste yielded a total suspended solids concentration of 3,963 mg/l. At a flow of about 13.4 cfs this amounted to 229,000 pounds per day. This is in good agreement with the stream data at NP191.6. The 73,500 pounds per day of suspended solids indicated at NP199.0 is puzzling because it does not check with either the waste effluent results or that at NP191.6. This anomaly can be resolved only through additional sampling, analysis, and field investigation.

The data indicate an increase in suspended solids of 75,000 pounds per day from the Great Western plant at Mitchell, Nebraska and an increase of 742,800 pounds per day from the Scottsbluff-Gering area. An increase of 292,200 pounds per day is indicated from Great Western at Bayard, Nebraska.

The suspended solids-PE values from these sources are listed in Table 8.

Comparison of the December suspended solids-PE's in Table 8 with those in Table 4 indicate reductions from all major sources since 1957. No in-plant surveys were made during December, and it is not possible to judge whether the apparent reductions in suspended solids resulted from changes within the plants. The 1957 inventory data (Table 4) were for the wastes as discharged, while the December 1960 values (Table 8) are based on stream data. It is probable that settling of portions of the suspended solids in the stream accounts for the lower values obtained from the stream data.

The high PE of 1,080,000 from the Great Western Bayard plant is surprising, in view of the provisions for broad field disposal of the wastes.

Total suspended solids in the Holly Sugar plant wastes were nearly 115 tons per day, of which 98 tons per day were fixed solids. Presumably most of the fixed solids were soil washed from the beets.

CHEMICAL

The pH values at all the stations were on the alkaline side. Averages were from 8.1 to 8.2.

No significant increases in phenolphthalein alkalinity or total alkalinity were apparent from the data at the stations above and below Holly Sugar Company. However, a significant increase in alkalinity was recorded below the Scottsbluff-Gering area. Total alkalinity at NP173.8 was 290 mg/l as $CaCO_3$ and at NP165.6 379 mg/l.

FIELD OVSERVATIONS

The river above Torrington was a beautiful, clear, sparkling stream. Below the Holly Sugar Company plant and downstream at least as far as Bridgeport the beauty of the stream was destroyed. Throughout the reach the water appeared brown, and numerous large particles of suspended solids were obvious at most stations. Luxuriant attached growths of slime covered the stream bottom at the bridge at NP178.0 , just upstream from Scottsbluff. The appearance of the river below Scottsbluff, at NP165.6, was worse than at any other station. The water was dark brown. Slime growths were attached to solid surfaces along the banks of the stream. Particles of grease floated on the surface of the water. The contrast of the dead and lifeless

appearance of the river here with the clear, sparkling water above Torrington was especially striking. There was some improvement in appearance downstream at NP154.6 and NP141.8, but the river at these stations still was disclored and murky with suspended solids.

COMPARISON WITH 1950 SURVEY

Table 9 presents average values of flow, D. O., BOD, and coliform organisms for surveys in 1950 and 1960 at comparable stations.

TABLE 9

COMPARISON OF 1950 DATA AND 1960 DATA

	1950				1960			
Station	Flow cfs	D.O. mg/l	BOD #/day	Coliform MPN/100 ml	Flow cfs	D.O. mg/l	BOD #/day	Coliform MPN/100 ml
NP208.8	-	10.6	-	-	-	11.03	-	-
NP199.8	377	6.22	49,900	60,200	278	8.57	86,000	329,000
NP191.6	593	7.47	38,800	51,000	328	9.70	41,740	132,000
NP165.6	1150	4.33	119,100	221,000	686	5.44	171,800	815,000
NP154.6*	1170	4.26	81,900	90,000	805	5.55	127,300	537,000
NP141.8	1550	7.89	46,100	177,600	943	8.04	110,620	279,000

*1950 Station at NP159.5

The D.O. values were higher in 1960 than in 1950. This is not a result of decreased waste loads, but probably because the temperatures in 1960 were lower than in 1950. Although both studies were made during the sugar beet campaign, the 1950 survey was in October-November of that year, while the 1960 survey was in December. As an example the water temperature at NP141.8 in 1950 was 11°C while in 1960 it was 0°C. Comparable temperature differences existed at the other stations.

At all stations the BOD loads were higher in 1960 than in 1950. This could result from the fact that natural self-purification is exerted at a slower rate at lower temperatures. Also, because the 1960 survey was later in the season, frozen and spoiled sugar beets may account for the greater pollutional loads.

Concentrations of coliform bacteria were higher at all stations in 1960 than in 1950. Increased sugar losses from frozen and spoiled beets may have served as increased nutriants that allowed greater multiplication of the bacteria in 1960 than occurred in 1950.

The data yield no evidence of reductions in waste discharges since 1950. In fact, the 1960 data indicate some increases in loads. The increases may be attributable to poorer condition of the raw beets in December 1960 than in October and November 1950.

SUMMARY AND CONCLUSIONS

Pollution of interstate waters of the North Platte River between Torrington, Wyoming, and Bridgeport, Nebraska were surveyed during November and December 1960. The two day biological survey in November intended primarily to determine effects of pollution on the stream's fishery, extended from Torrington downstream across the Wyoming-Nebraska state line to Morrill, Nebraska. The seven day December survey, from Torrington downstream to Bridgeport measured bacteriological, chemical, and physical effects of pollution.

The November survey was conducted by personnel of the U.S. Public Health Service Regional Office in Kansas City, Missouri. The December survey was conducted by personnel of the U. S. Public Health Service Regional Office in Denver, Colorado, and the Robert A. Taft Sanitary Engineering Center at Cincinnati, Ohio. Laboratory facilities were made available by the Scottsbluff Branch Laboratory of the Nebraska State Department of Health. Personnel of the branch laboratory cooperated by conducting the examinations for coliform bacteria.

Principal sources of wastes discharged to this reach of the North Platte include the Holly Sugar Company plant at Torrington, Wyoming, four Great Western Sugar Company plants at Mitchell, Scottsbluff, Gering, and Bayard, Nebraska, the Swift and Company meat packing plant at Gering, and raw sewage from the Scottsbluff-Gering area. Torrington, Wyoming, formerly discharged raw sewage to the North Platte, but has installed waste stabilization ponds for sewage treatment. There was no evident discharge of sewage from the ponds during the survey.

Above the Holly Sugar Company plant at Torrington, the North Platte River presented every appearance of a clean stream. When not affected by the turbidity introduced by surface runoff following rainfall this water was beautifully clear and sparkling.

The clean appearance was confirmed by the results of the survey. Aquatic life was found to be normal for clean water. Coliform bacteria were quite low. Dissolved oxygen was high, and BOD and suspended solids were low.

Below the Holly Sugar Company waste discharges, the change in appearance of the water was drastic. The clarity of the stream gave way to a murky brown color. Numerous large particles of suspended matter were evident at downstream sampling stations. As wastes from successive downstream sources in Nebraska entered the stream the unwholesome appearance of the stream became progressively worse. At the Minatare, Nebraska, sampling station, below the Scottsbluff-Gering area, the stream exhibited its most unpleasant appearance. The water here was extremely dark, and appeared dull and lifeless. In addition, grease particles and scum floated on the surface. From this station downstream there was some improvement, but even at Bridgeport the stream still was murky brown and carried quantities of suspended particles.

The results of the stream study confirmed the apparent degradation of the river below the Holly Sugar Company plant, and downstream to Bridgeport.

No submerged plant growth was observed under water carrying the beet wastes below Torrington. Only those bottom animal forms that are very tolerant of pollution were found in such areas and even these types were rare. Particles of beet trash littered the bottom. No fishes were observed. As noted earlier, the biological examinations were carried as far downstream as Morrill, Nebraska, only and therefore did not reflect the effects of sugar beet and other wastes discharged to the North Platte River in Nebraska.

Coliform bacteria rose from 214 per 100 ml above the Holly Sugar plant to more than 300,000 per 100 ml below the plant, near the Wyoming-Nebraska state line, and did not fall below 100,000 per 100 ml at any station as far downstream as Bridgeport. A peak of more than 800,000 per 100 ml occurred below the Scottsbluff-Gering area. The BOD increased from 1.41 mg/l above the Holly Sugar plant to 57.3 mg/l near the state line, and did not drop below 21.7 mg/l at any downstream station. The D.O. dropped from 11.03 mg/l above Torrington to 8.57 mg/l near the state line. The lowest average at any station was 5.44 mg/l below the Scottsbluff-Gering area, with recovery to 8.04 mg/l at Bridgeport. Suspended solids rose from 7.83 mg/l above the Holly Sugar plant to 48.9 mg/l near the state line and to 133 mg/l above Mitchell, Nebraska. Maximum suspended solids were 284 mg/l below the Scottsbluff-Gering area. The Holly Sugar Company wastes carried nearly 115 tons per day of solids of which 98 tons per day were fixed solids. Most of the fixed solids presumably were soil washed from the beets.

Comparison of the 1960 survey results with the results of a stream study in 1950, and with the U. S. Public Health 1957 inventory of wastes, indicates no significant improvement in stream conditions or in waste loads in the interim periods. As a matter of fact, waste loads generally were somewhat greater in 1960 than previously. The indicated increases may have resulted from deterioration of the raw beets by the cold, wet weather that proceeded the 1960 study.

The following conclusions are drawn from the results of the study:

1. The natural, beautiful appearance and the scenic value of the North Platte River above Torrington, Wyoming, is destroyed by the discharge of sugar beet wastes from the Holly Sugar Company plant. Four plants of the Great Western Sugar Company, and municipal sewage and other industrial wastes downstream in Nebraska contribute to the deterioration in appearance, and maintain the unsightly conditions at least as far downstream as Bridgeport, Nebraska.

2. The wastes from the Holly Sugar Company plant at Torrington eliminate desirable types of aquatic plant and animal life necessary for propagation of fishes, and destroy the potential fishery of the river at least as far downstream as Morrill, Nebraska, where the biological survey terminated. Consideration of other waste loads discharged to the river in Nebraska below Morrill and of the results of chemical and physical analyses and visual observations indicates that the stream's potential fishery is destroyed, or at least severly limited, as far downstream as Bridgeport.

3. Concentrations of coliform bacteria in the river from below Torrington to Bridgeport are 26 to 163 times the 5,000 per 100 ml ordinarily considered to be the maximum acceptable in waters used as sources of municipal supply, and for general recreation such as fishing and boating.

4. The heavy organic load imposed on the stream by the wastes, as reflected by the high BOD values, renders the water unsuitable as a potential source of municipal water supply and also unsuitable for many industrial uses.

5. The average D.O. did not drop below the 5 mg/l minimum, usually considered desirable, during the December 1960 study. However, with comparable waste loads and stream flows earlier in the sugar beet campaign, when stream temperatures were higher, minimum D.O. values almost certainly would have been below 5 mg/l.

6. Suspended solids contributed by the wastes settle to the bottom of the stream and interfere with normal growth of aquatic plant and animal life necessary for the propagation of fishes. If use of the stream as a source of municipal or industrial water supply should become desirable, the necessary treatment for removal of the suspended solids would be both costly and difficult.

7. Wastes from the Holly Sugar Company plant carried nearly 115 tons per day of suspended solids, of which 89.5 per cent were fixed solids. Presumable soil washed from the beets constituted most of the fixed solids.

8. The Holly Sugar Company plant causes interstate pollution of the North Platte River in Nebraska.

9. Wastes from four Great Western Sugar Company plants, and from municipalities and other industries in Nebraska, principally in the Scottsbluff-Gering area, add to the residual pollution from the Holly Sugar Company to maintain conditions of gross pollution of the North Platte at least as far downstream as Bridgeport, Nebraska.

10. Principal damages to immediate uses of this reach of the North Platte River are the hazard to health from raw sewage discharges, destruction of the river's fishery, and degradation of the stream's scenic value. There would be damage to potential uses of the stream, such as use for a source of municipal or industrial water supply if such uses should become desirable.

11. Water quality has not improved significantly, and waste loads have not been reduced effectively since 1950.

APPENDIX

APPENDIX

NORTH PLATTE RIVER STREAM SURVEY
WYOMING-NEBRASKA
DECEMBER, 1960
RESULTS OF ANALYSIS

Station	Date Dec.1960	Time Collected	Flow cfs	Temp. °C.	pH	Alkalinity P(asCaCO3)	Alkalinity Total	Dissolved Oxygen mg/l.	Dissolved Oxygen % Sat.	BOD mg/l	BOD lbs/day	Total Suspended Solids mg/l	Total Suspended Solids lbs/day	Coliform MPN/100	Fixed Suspended Solids mg/l	Fixed Suspended Solids lbs/day
HS-1	7	1:45 PM		34								7,940			7,100	
	8	8:20 AM		34								4,700			4,140	
	9	10:30 AM		41								2,980			2,520	
	10	7:15 AM		35								836			528	
	11	7:40 AM		36								724			508	
	12	1:15 AM		38								1,860			1,460	
	13	9:40 AM		35								3,100			2,660	
Avg.				36								3,163			2,702	
NP-208.8	7	1:45 PM	278	2	8.2		216	11.40	94	1.11	1,666	8.0	12,000	91		
	8	8:20 AM	278	0	8.0		218	11.33	89	1.19	1,786	2.2	3,300	91		
	9	10:30 AM	278	0	8.2		216	9.49	75	1.13	1,696	9.0	13,500	< 36		
	10	7:15 AM	278	0	8.0		217	11.01	87	1.30	1,951	4.83	7,250	230		
	11	7:40 AM	278	0	8.1		214	11.06	87	2.04	3,062	4.5	6,750	430		
	12	1:15 PM	278	2	8.3	2.2	223	11.60	96	1.39	2,086	17.8	26,720	230		
	13	9:40 AM	278	0	8.2		216	11.30	89	1.71	2,567	8.5	12,760	430		
Avg.			278	0.5	8.1	0.3	217	11.03	88	1.41	2,116	7.83	11,750	214		
NP-199	7	1:15 PM	290	1	8.0		251	8.75	72	59.8	93,650	54.5	85,350	93,000		
	8	8:50 AM	270	0	8.0		249	8.58	68	50.7	73,920	49.0	71,440	460,000		
	9	11:00 AM	280	0	8.1		244	8.71	69	49.0	74,090	51.7	78,170	75,000		
	10	7:05 AM	280	0	8.0		249	8.51	67	63.0	95,260	48.5	73,330	240,000		
	11	8:10 AM	280	0	8.0		244	8.41	66	56.0	84,670	47.0	71,060	240,000		
	12	1:45 PM	275	2	8.2		254	8.44	71	63.0	93,560	45.0	66,820	93,000		
	13	9:20 AM	270	0	8.1		246	8.57	68	59.6	86,900	46.8	68,230	1,100,000		
Avg.			278	0.4	8.1		247	8.57	69	57.3	86,000	48.9	73,500	329,000		
NP-191.6	7	12:45 PM	328	0	8.1		243	9.39	74	22.8	40,380	146	258,600	43,000		
	8	9:20 AM	328	0	8.0		243	9.49	75	19.4	34,360	169	299,300	43,000		
	9	11:20 AM	328	0	8.1		248	11.33	89	23.0	40,730	150	265,600	93,000		
	10	6:45 AM	328	0	8.0		242	9.50	75	24.2	42,860	104	184,200	460,000		
	11	8:45 AM	328	0	8.1		238	9.44	74	20.8	36,840	150	265,600	93,000		
	12	2:10 PM	328	2	8.2		242	9.34	78	31.3	55,430	104	184,200	43,000		
	13	9:00 AM	328	0	8.1		240	9.42	74	23.5	41,620	106	187,700	150,000		
Avg.			328	0.3	8.1		242	9.70	77	23.6	41,740	133	235,000	132,000		

APPENDIX

NORTH PLATTE RIVER STREAM SURVEY (CONTINUED)

WYOMING-NEBRASKA

DECEMBER, 1960

RESULTS OF ANALYSIS

Station	Date Dec.1960	Time Collected	Flow cfs	Temp. °C.	pH	Alkalinity P(as $CaCO_3$)	Alkalinity Total	Dissolved Oxygen mg/l.	Dissolved Oxygen % Sat.	BOD mg/l	BOD lbs/day	Total Suspended Solids mg/l	Total Suspended Solids lbs/day	Coliform MPN/100	Fixed Suspended Solids mg/l	Fixed Suspended Solids lbs/day
NP-173.8	7	3:45 PM	466	0	8.1		290	8.47	67	25.9	65,160	133	334,600	150,000		
	8	11:00 AM	450	0	8.1		295	8.60	68	22.2	53,950	161	391,200	930,000		
	9	9:20 AM	450	0	8.1		293	8.30	65	19.0	46,170	152	369,400	---		
	10	8:05 AM	442	0	8.0		286	8.21	64	17.8	42,470	104	248,100	2,400,000		
	11	12:30 AM	446	1	8.1		288	8.20	66	21.2	51,050	130	313,000	930,000		
	12	2:45 PM	438	1	8.2		296	8.25	67	24.8	58,650	132	312,200	93,000		
	13	8:20 AM	434	0	8.1		283	8.44	66	24.7	57,870	86	201,500	430,000		
Avg.			447	0.3	8.1		290	8.34	66	22.2	53,620	128	310,000	704,000		
NP-165.6	7	9:15 AM	669	0	8.3	4.4	370	6.28	49	48.2	174,100	267	964,700	1,100,000		
	8	12:30 PM	701	1	8.1		365	5.80	47	40.4	152,900	272	1,029,500	750,000		
	9	8:50 AM	701	0	8.2		387	5.00	39	42.9	162,400	302	1,143,100	---		
	10	8:45 AM	683	0	8.1		378	5.07	39	41.5	153,000	263	969,900	430,000		
	11	12:05 PM	687	2	8.1		380	4.71	39	46.0	170,700	270	1,001,700	930,000		
	12	11:05 AM	683	0	8.3	0.6	402	5.67	44	46.1	170,000	335	1,235,500	750,000		
	13	7:55 AM	678	0	8.3	2.0	375	5.55	44	59.9	219,300	260	1,025,100	930,000		
Avg.			686	0.4	8.2	1.0	379	5.44	43	46.4	171,800	284	1,052,800	815,000		
NP-154.6	7	10:00 AM	805	0	8.4	1.6	341	6.90	54	28.2	122,600	175	760,700	240,000		
	8	1:05 PM	805	1	8.2		384	6.04	49	28.8	125,200	284	1,234,500	150,000		
	9	8:20 AM	805	0	8.2		372	5.41	43	24.3	105,600	284	1,234,500	930,000		
	10	9:10 AM	805	0	8.1		365	5.37	42	24.6	106,900	268	1,165,000	930,000		
	11	11:35 AM	805	1	8.2		369	4.21	34	> 37.1*	-	240	1,043,300	930,000		
	12	10:30 AM	805	0	8.1		382	5.63	44	31.9	138,700	270	1,173,700	430,000		
	13	7:30 AM	805	0	8.3	2.0	382	5.31	42	37.9	164,800	244	1,060,700	150,000		
Avg.			805	0.3	8.2	0.5	371	5.55	44	29.3	127,300	252	1,096,000	537,000		
NP-141.8	7	10:30 AM	943	0	8.2		330	8.81	69	16.0	81,470	143	728,100	93,000		
	8	1:40 PM	952	0	8.2		436	8.06	64	29.3	150,600	458	2,354,100	75,000		
	9	7:45 AM	972	0	8.1		382	7.90	62	20.2	106,000	278	1,458,900	460,000		
	10	9:35 AM	952	0	8.1		397	7.93	62	23.7	121,820	332	1,706,500	460,000		
	11	11:05 AM	943	0	8.1		369	7.48	59	20.2	102,860	274	1,395,200	390,000		
	12	9:50 AM	943	0	8.1		374	8.03	64	23.6	120,170	240	1,222,100	240,000		
	13	7:05 AM	896	0	8.2		354	8.11	64	18.9	91,440	182	880,050	240,000		
Avg.			943	0	8.1		377	8.04	63	21.7	110,620	272	1,392,170	279,000		
NP-62.0	9	3:15 PM		3				13.60	116							
	12	8:00 AM		2				13.07	109							
Avg.								13.33	112							

*Omit